Report

ID: 120090645

Name: Haopeng Chen

Selected Paper: Te-Yuan Huang, Ramesh Johari, Nick McKeown. ***Downton Abbey Without the Hiccups: Buffer-Based Rate Adaptation for HTTP Video Streaming***.

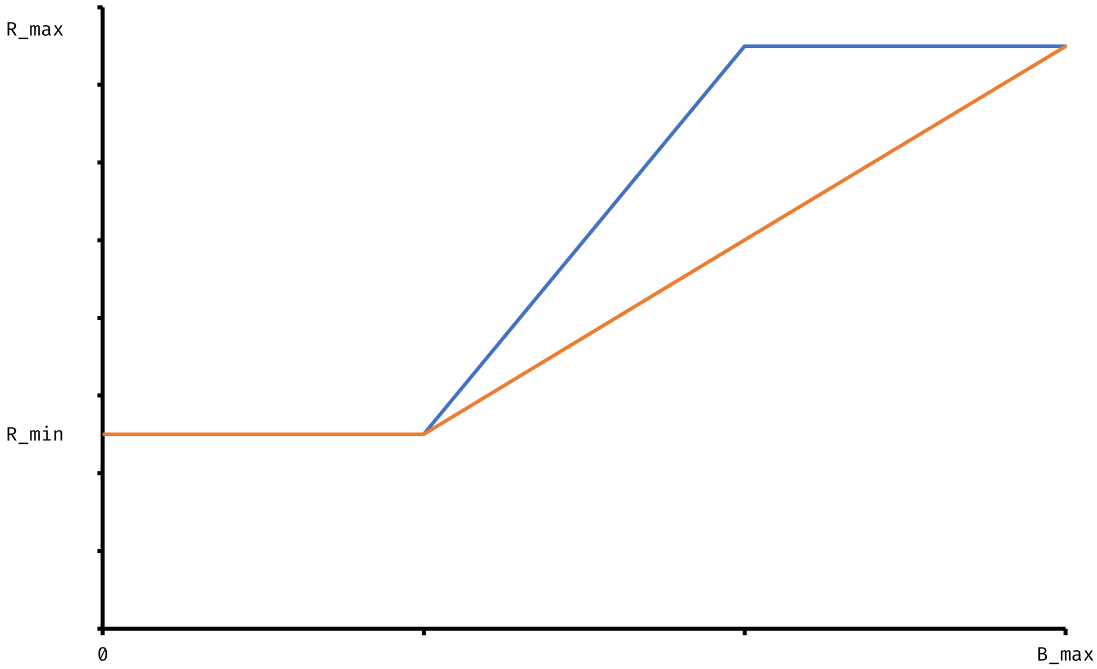
Algorithm Analysis

Algorithm: Video Rate Adaptation Algorithm

```
Hyperparameters:
    R_M: All available bitrates, bits per second
    R_max: Maximum available bitrate, bits per second
    R_min: Minimum available bitrate, bits per second
    R_i: i-th available bitrate inside R_M, bits per second
    mapping_func: a mapping function to transfer buffer occupancy to designated bitrate mathematically.

Input:
    Rate_prev: The previously used video rate, bits per second
    Buf_now: The current buffer occupancy, second

Output:
    Rate_next: The fetched video rate, second

# Select adjacent possible values from R_M, larger and smaller respectively
if Rate_prev == R_max:
    Rate_plus = R_max  # Could not increase any more
else:
    Rate_plus = min{R_i : R_i > Rate_prev}  # next larger step
if Rate_prev == R_min:
    Rate_minus = R_min  # Could not decrease any more
else:
    Rate_minus = max{R_i : R_i < Rateprev}  # next smaller step

# Check the mapping function to see whether should move up/down to next step. If so, move to the step nearest to the bound, skipping intervals (if exists).
if mapping_func(Buf_now) >= Rate_plus:
    Rate_next = max{R_i : R_i < mapping_func(Buf_now)}
elif mapping_func(Buf_now) <= Rate_minus:
    Rate_next = min{R_i : R_i > mapping_func(Buf_now)}
else
    Rate_next = Rate_prev

return Ratenext
```

Mapping Function

The orange line represents the naive implementation from the paper, while the blue line is my enhanced version. By selecting the `R_max` at lower buffer occupancy, a.k.a. `B_t`, we are able to achieve higher average bitrate. According to the paper, the plain part for small `B_t`, **reservoir**, is with the length of $V \times \frac{R_{\max}}{R_{\min}}$, where V is the duration of a chunk.



I set the upper plain part with the length of **twice** as **reservoir** if possible. If this is not a valid value, it will try to find the most nearest valid one, moving to `B_max` one by one. This enhanced mapping function gives better performance, especially on good network condition (faster convergence).

Implementation

```
def mapping_func(buffer_now):  4 usages
    """
    The mapping function between buffer occupancy and bitrate.

    Args:
        buffer_now: The current buffer occupancy, in seconds

    Returns:
        The corresponding bitrate
    """

    global RESERVOIR, B_MAX, R_MIN, R_MAX, RMAX_POINT

    if buffer_now <= RESERVOIR:
        return R_MIN
    elif buffer_now >= RMAX_POINT:
        return R_MAX
    else:
        return R_MIN + (R_MAX - R_MIN) * (buffer_now - RESERVOIR) / (RMAX_POINT - RESERVOIR)
```

```python
def video_rate_adaptation_algo(rate_prev, buffer_now):  1 usage
    """
    This function is called every time a new video chunk is requested.

    Args:
        rate_prev: The previously used video rate, in bits per second
        buffer_now: The current buffer occupancy, in seconds

    Returns:
        The next video rate
    """

    global R_MIN, R_MAX, AVAILABLE_BITRATES

    if rate_prev == 0:
        return R_MIN  # Fast-track the case when rate_prev is 0 for the first chunk

    # Set rate_plus to lowest reasonable rate
    if rate_prev == R_MAX:
        rate_plus = R_MAX
    else:
        rate_plus = min([rate for rate in AVAILABLE_BITRATES if rate >= rate_prev])
    # Set rate_minus to the highest reasonable rate
    if rate_prev == R_MIN:  # Consider the case when rate_prev is 0 for the first chunk
        rate_minus = R_MIN
    else:
        rate_minus = max([rate for rate in AVAILABLE_BITRATES if rate <= rate_prev])

    # Select bitrate according to mapping func result
    if mapping_func(buffer_now) >= rate_plus:
        rate_next = max([rate for rate in AVAILABLE_BITRATES if rate <= mapping_func(buffer_now)])
    elif mapping_func(buffer_now) <= rate_minus:
        rate_next = min([rate for rate in AVAILABLE_BITRATES if rate >= mapping_func(buffer_now)])
    else:
        rate_next = rate_prev

    return rate_next
```

Evaluation

Naive / Mine	Avg. Bitrate	Buffer Time	Switches	Score
badtest	2166666 / 633333	73 / 1	23 / 1	7518 / 553192
testALThard	2166666 / 633333	72 / 1	22 / 1	8535 / 553504
testALTsoft	3816666 / 1583333	27 / 0.202	10 / 2	407852 / 1326319
testHD	4566666 / 1583333	0.202 / 0.202	2 / 2	3825384 / 1326319
testHDmanPQtrace	50000 / 50000	242 / 242	0 / 0	0.197 / 0.197
testPQ	50000 / 50000	246 / 246	0 / 0	0.162 / 0.162

This is the comparison table between the example code and my implementation. We can easily find out the last two row share the same statistics, which means that they perform similarly under bad network condition. As for the first three ones, they indicate that my implementation outperform the given one on fluctuated network. For the HD test, it shows that my implementation does not achieve the highest bitrate as quick as the given one.